



Brookhaven National Laboratory

SNS

Ring and Transfer Lines Systems

NOVEMBER

MONTHLY REPORT

01 November – 30 November 2002

Performing Organization:
Location:

Brookhaven Science Associates
Brookhaven National Laboratory
Upton, New York 11973-5000

Contract Period:

October 1998 – June 2006

Brookhaven National Laboratory
SNS MONTHLY PROGRESS REPORT
November 2002
Ring and Transfer Lines Systems

I. Senior Team Leader Assessment

1. TECHNICAL PROGRESS AND ACCOMPLISHMENTS

- The first Ring half-cell magnet assembly was safely delivered to ORNL, two months ahead of schedule.
- The semi-annual Lehman Review was held on SNS. The Ring system performance at BNL was determined to be on time, within budget baseline, and on scope. The review committee recommended to execute a full magnet-measurement plan, and supported the implementation of new-scope machine-improvement measures recommended by the Accelerator System Advisory Committee.
- For the coming 2003 Particle Accelerator Conference, BNL/SNS staff is preparing to submit about 40 abstracts for presentations at the conference. Among them are three invited talks.
- Efforts on shimming and measurements of the ring main dipole magnets are completed. Comparing with as-built, rms variation in the integral transfer function is reduced by a factor of 17 to 0.01%.
- All ring dipoles are sorted to optimize their performance at both the nominal (1 GeV) and upgradeable (1.3 GeV) energies.
- The Lambertson extraction septum magnet is successfully design-iterated to reduce the fringe magnetic fields. Similar efforts are launched to reduce the fringe-field deviation of injection chicane magnet (#4).

2. ISSUES AND ACTIONS

- ASAC Recommendations, supported by the recent DOE Review, needs to be authorized, funded and implemented. Awaiting Project direction.

3. COST AND SCHEDULE STATUS

3.1 VARIANCE ANALYSIS AND PROJECT COST PERFORMANCE REPORTS

WBS 1.1.3 R&D

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
5115.0	5115.0	5112.9	0.00	0.0%	2.1	0.0%

Variance Statement: Cum variances are within thresholds. No analysis required.
No current period activity.

Project Impact: None.

Corrective Action: None.

WBS 1.5 Ring and Transfer Lines

BCWS	BCWP	ACWP	SV	%	CV	%
62568.4	61909.9	61606.1	(658.51)	-1.1%	303.7	0.5%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period SV is driven by WBD 1.5.1, 1.5.2, 1.5.4 & 1.5.8.

Project Impact: None.

Corrective Action: None

3.2 MILESTONE STATUS

WBS 1.5 and 1.1.3 have no level 0 milestones. Milestone status is listed below.

Milestones	Level 1	Level 2	Level 3	Level 4	Level 5
Project	0	1	3	13	127
FY03	0	0	0	0	20
Due in Next 30 days	0	0	0	0	1
Total Due at present	0	0	3	12	108
Made	0	0	3	12	98
Missed	0	0	0	1	10
Ahead of Schedule	0	0	0	0	0

3.3 PROJECT CRITICAL PATH ANALYSIS

The critical path item is Ring Diagnostics.

II. Detail R&D Subproject Status

WBS 1.1.3 – Ring System Development

All work covered by R&D funds is essentially complete.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
5115.0	5115.0	5112.9	0.0	0.0%	2.1	0.0%

Variance Statement: Cum variances are within thresholds. No analysis required.
No current period activity.

Project Impact: None.

Corrective Action: None.

III. Detail Line Item Subproject Status

WBS 1.5.1 – HEBT Systems

Phone conferences continued with Tesla during the month on the HEBT dipole magnet. They are preparing the final HEBT dipole magnet for shipment. They have tentatively scheduled delivery of the first HEBT/RTBT 21Q40 magnets for March 2003. Phone conferences with Danfysik have come to an end since they have completed all of their magnet production work for SNS. Both vendors were visited during the month. The stands for the 12Q45/16CD20 are nearly complete and will be shipped in December.

The design of the 12cm quadrupole chambers adjacent to the collimators was modified to provide more space for collimator flange assemblies. The design of the Linac dump line vacuum has begun.

Drawings of the HEBT momentum dump are being reviewed. Fabrication of the HEBT collimators has started. Outer shield arrangements have also been designed, and are being reviewed.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
5759.0	6277.1	4986.7	518.19	9.0%	1290.5	20.6%

Variance Statement: Cum CV of \$1290.5K (20.6%) is material driven by 1.5.1.1.1 HEBT 8D533 Magnet, whereas 9 of 9 magnets were received (628K). ACWP is understated and will be accrued in a subsequent current period. All Danfysik HEBT Quad & Corrector Magnets are received, accounting accrual will follow. Current period CV -\$145K (-406.3%) is driven by WBS 1.5.1.5 labor whereas an adjustment will be made in a subsequent period to reflect BCWP.

Project Impact: None.

Corrective Action: None.

WBS 1.5.2 – Injection Systems

The Wedge-shape clamping parts designed to reduce the coil vibration have been made and installed in the first article magnet. The full power test is waiting for a burned capacitor in the power supply to be repaired. The test will include a TiN coated test ceramic tube (without flanges). At this time the baseline does not include magnetic measurement of the injection kicker so this testing will not be done.

Ameriflex has delivered 6 bellow bodies and 4 bellow assemblies with flanges welded (two more assemblies to be delivered). These bellows are being leak checked by Beam component group.

The first two ceramic chambers are in the vacuum lab awaiting Titanium-Nitride coating. Macro Metalics is the lowest bidder and has been awarded the contract to make the 4 short magnet ceramic chambers. A P.O. for 5 more long kicker chambers has been placed with Ceramaseal. Ceramic Magnetics Inc. is ready to ship the first set of short magnet ferrites for acceptance test. Central shop is working on the production magnet parts. Many parts have been made and will be moved to Bldg. 919 for cleaning and assembly.

The number 4 injection chicane magnet has been acceptance tested and magnetic measurement is underway. It has been measured with an NMR as a function of current. A harmonic coil has been surveyed onto the mechanical centerline. The drawings for the number 1 chicane magnet are being checked.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
4815.9	5164.8	5089.4	348.91	7.2%	75.4	1.5%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period CV -\$132.6K (-338.8%) is driven by an accounting accrual for WBS 1.5.2.1 material, whereas BCWP was taken in a previous current period.

Project Impact: None.

Corrective Action: None.

WBS 1.5.3 – Magnet Systems

The first half-cell was shipped on November 5 and received on November 7 at the RATS building. The shipping container and support frame worked well. The next half cell base has been moved into 902 to assembly area.

At this time all of the 17D120 ring dipole magnets (ITF that is $<1 \times 10^{-4}$ from the nominal value) have magnetically measured and accepted. Matching of the magnets has been completed. Four of the magnets will have to be flipped from right hand to left hand configuration in order to complete the matching. The 17D120 measurement stand will now be reconfigured for the new 26cm measuring coil. Work on this new coil, which will be used to measured 26cm and larger quadrupoles and related correctors, is well along. Most parts needed to connect it to the (existing) drive have been made.

There are now 23 - 21Q40's now at BNL. The last batch of magnets will be shipped in December. Production measurements of the nine 21Q40 have been completed. Replacement of the fittings is underway but going slowly – it takes 2 _ days to replace a set of fittings on one magnet. Because of repairs to the water fittings on these quadrupoles, a group of them was not available for magnetic measurement during November.

Measurements of the 26Q40 with a second modification of the pole end chamfer have been completed and the magnet has been approved for production.

The ECN for the 30Q58 was completed and approved and BINP has been given the go ahead for production. They provided a brazing sample for the stainless steel fitting that looks acceptable. Parts have been ordered here that will be shipped to them for the production lot of magnets. They provided a fabrication schedule that states that they will deliver the first three production 30Q58's in March with the 1st article 30Q44.

The ninth and last 21CS26 sextupole corrector magnet was measured. Eight of these corrector sextupoles are tightly grouped in transfer function (std. dev. ~ 0.1%). These will be installed. The ninth sextupole has a transfer function that is ~ 0.3% lower than the rest. It will be the spare. A schedule of production measurements for the 21cm multipole magnets has been re-defined again. At this time the next set of magnets to be measured is the 27CDM30 (all magnets) and then back to finding 21Q40 families after the water fittings are repaired. The time to measure the 27CDM30's has been cut to one day. Five of these correctors have been measured. For the first magnet, the survey group established the position of the measuring coil with respect to the magnet. This survey information is less critical for correctors than for the quadrupoles and dipoles, and it was decided to not survey the remaining correctors of this type in order to speed up and minimize the cost of the magnetic measurements.

On the 21S26, Alpha sent us the proposed schedule. The 12/21/02 delivery date for "first article" was not acceptable but they didn't want to bring it closer. A visit/inspection will be paid to them next month to verify progress. The 26S26 high field sextupole was sent out for bid. The bids are due December 5.

New England TechniCoil shipped a rewound coil for the 36CDM30. They were given the "go ahead" after the new pole was measured and tested in house with relatively good results (was still presenting approx. 0.100" bowing in the center of the pole). A visit/inspection will be made next month to verify progress.

On the 41CDM30, Alpha Magnetics stated that they have all the materials in house. A visit/inspection will be paid to them next month to verify progress. Their proposed schedule was accepted. (Delivery is supposed to start on 12-16-02 and end on 02-10-03).

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
11244.9	11100.4	11570.7	(144.51)	-1.3%	(470.3)	-4.2%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period CV -\$162.3K (-134.3%) is driven by WBS 1.5.3.1 High Field Magnet Measurement, whereas an accounting accrual for labor and material exceeded BCWP.

Project Impact: None.

Corrective Action: None.

WBS 1.5.4 – Power Supply Systems

- All contracts have been awarded, we're keeping track of vendors, and low field correctors continue to be delivered. There were no other deliveries in the month of November.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
1238.1	978.4	1163.8	(259.74)	-21.0%	(185.4)	-18.9%

Variance Statement: Cum SV of -\$259.7K (-21.0%) & CV -\$185.4K (-18.9%) are driven by Ring Quad PS & Ring Low Field PS deliveries and labor issues. Current period CV -\$37.3K (-317.8%) is driven by WBS 1.5.4.2 Main Ring PS material whereas an accounting accrual (ACWP) was not offset by current period BCWP.

Project Impact: None.

Corrective Action: None.

WBS 1.5.5 – Ring Vacuum System

- Quick disconnect flange assemblies with 14" opening were successfully tested using Helicoflex Delta seals. EVAC aluminum diamond seals with retaining rings of the same dimension will be tested next. Delivery of TMP Carts to SNS from Varian continues. Order for the last eight EPDM sealed TMP isolation gate valves was placed.
- All the PLC chassis, modules and wiring components for HEBT, Ring, and RTBT vacuum systems have been delivered. Two vacuum PLC chassis have been assembled into the test rack. Progress has been made on serial device support, ControlNet communication between PLCs and EPICS RDB tools. Progress has also been made on the conversion of PLC5 ladder logic to ContrlLogix ladder logic.
- Papers on chamber outgassing rates with and without TiN coatings were presented at two vacuum conferences. Several abstracts on SNS vacuum were submitted to PAC03. A PCR for spare ring vacuum chambers was prepared and submitted. A PCR for the scope transfer of residual gas analyzers is being prepared.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
5225.1	5130.1	5314.7	(95.00)	-1.8%	(184.6)	-3.6%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period CV -\$84.9K (-141.5%) is material driven by 1.5.5.4 Ring Vacuum Instrumentation; whereas BCWP for material is understated and will be adjusted in a subsequent current period.

Project Impact: None.

Corrective Action: None.

WBS 1.5.6 – RF System

- Assembly of the cavities and power amplifiers continued.
- Tests of the first article cavity continued.
- The A/D daughter card prototype is in manufacturing and is due late December.
- The prototype LLRF control application with GUI is being tested.
- IQ loop code development for the DSP continues
- Significant progress in the ep study was made. After the DOE review it was found that nonlinear space charge forces can have a significant effect on the instability threshold. The theory is now in much better agreement with PSR data. In particular, the scaling of the instability threshold with bunch length now has a first principles explanation. The article submitted to The Physical Review has been modified to include this new progress. At this point it looks like only a few loose ends remain.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
7544.0	7278.4	7355.2	(265.52)	-3.5%	(76.7)	-1.1%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period SV \$81.8K (64.6%) is material driven deliveries for WBS 1.5.6.2.1 RF Beam Control Sys; whereas performance (BCWP) was recorded against prior period BCWS.

Project Impact: None.

Corrective Action: None.

WBS 1.5.7 – Ring Diagnostics

- SNS Ring Diagnostics presentation was completed at the DOE Review.
- The final five 26cm BPM PUEs were delivered to the Vacuum Group for final welding into the beampipes. Design continues on the BPM IFE and the baseband/RF multiplexer.
- Detailed design of the IPM electromagnets was completed, and a cost estimate was prepared. Detailed design of the detector and vacuum chamber continues. Work continues on the luminescence profile monitor. Five Argonne-style electron detectors were installed in the RHIC ring for testing and cross-calibration with the CERN style detectors (as well as the RHIC IPM).
- Efforts continue on the PCB design of the BLM AFE module, MPS comparator module and crate back plane. Design of testing fixture for the AFE is underway. An order has been placed for 15 end-cap RC network PCBs. Confirmed delivery of 10 LND (new ION chamber design) in mid January. Discussions continue with ORNL to specify cables and connectors. We continue to prepare for DTL commissioning at ORNL. Email discussions are underway with A. Feschenko regarding neutron detector design and integration.
- Work is proceeding on evaluating BCM software changes in support of MEBT commissioning. Assembly of the prototype HEBT BCM toroid/vacuum chamber is progressing. The unit is ready for the assembly. Looking into hysteresis affects due to the transformer core to determine the effect upon droop calculations.
- Drawings for the MEBT wire scanner were updated to the present configuration.
- The carbon fiber plating procedure was documented. Submitted a HEBT beam box design to LANL to finalize the design parameters of the custom made beam box. A HEBT wire scanner beam box was designed to accept LANL's 5.78" wide fork and to accommodate the laser wire ports. Obtained a quote for this design, and a purchase order has been written.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
7348.4	7014.1	7018.3	(334.23)	-4.5%	(4.2)	-0.1%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period CV -\$37.2K (-29.3%) is material (-20K) and labor (-19K) driven by WBS 1.5.7.1 (-\$39K).

Project Impact: None.

Corrective Action: None.

WBS 1.5.8 – Collimation and Shielding

- Work is continuing on the first scraper for the Ring. The ring secondary and tertiary absorber drawings are being reviewed. Finally, the vacuum chambers before and after the primary collimator are being integrated with the collimator.
- Drawings of the modified shield are complete. A review with project office staff was carried out, and the drawings are now in checking.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
1839.5	1651.4	1713.3	(188.0)	-10.2%	(61.8)	-3.7%

Variance Statement: Cum schedule variance (SV) of -\$188K (-10.2%) is material driven by 1.5.8.1 Ring Collimator 1st delivery; whereas 1st delivery will be in March '03 thus reducing the SV. Current period CV -\$47.7K (-299.4%) is labor driven by WBS 1.5.8.1 Ring Collimator and Shielding.

Project Impact: None.

Corrective Action: None.

WBS 1.5.9 – Extraction System

- The checking of the drawings for the down stream end kicker assembly is moving along. Physicists and electrical engineers have checked the polarity of the kicker coil to high voltage feedthrough. To avoid any future mistakes, a revision was made to the kicker design to make the polarity reversible. The upstream kicker assembly design is moving along and will be finished soon. APS of Long Island NY has started the construction of the PFN. After low mu test, the prototype kicker magnet will be reassembled with CMD5005 ferrite for full power test.
- Redesign of Extraction Lambertson Septum Magnet continues with new parameters, which allow optimization of electromagnetic shielding for the ring's circulating beam.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
1786.2	1776.5	1844.7	(9.73)	-0.5%	(68.2)	-3.8%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period SV \$61.9K (142.4%) is labor driven by WBS 1.5.9.3.; whereas magnet design was completed and performance (BCWP) was recorded against prior period BCWS.

Project Impact: None

Corrective Action: None.

WBS 1.5.10 – RTBT System

Ranor has shipped the first cores for the large aperture radiation resistant quadrupoles. Three of the cores were received here at the end of the month. The 923 assembly area is being reconfigured to allow winding of the first production coils for the radiation resistant magnets.

RTBT Vacuum System has been finalized. The support scheme has been improved to insure against gate valve vibration. Certain "hot area" bellows have been integrated into magnet chambers. BOM's are finalized and orders for commercial components are being drafted.

A modified top plate of the inner shield box has been designed and is being qualified. The technique developed for this collimator will be used on the ring collimators as well.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
3163.2	2934.4	3147.2	(228.85)	-7.2%	(212.8)	-7.3%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period SV of \$27.3K (50.6%) is driven by a 6% increase to % complete to WBS 1.5.10.1, RTBT Magnet Design & Support.

Project Impact: None.

Corrective Action: None.

WBS 1.5.12 – Technical Support

- During November, staff supported the DOE review. About 40 abstracts from the group were submitted to PAC03
- Dipole sorting is completed.
- AP group approval was given to mass production of 30Q44 and 26Q 44
- Lamberton magnet was optimized for the fringe fields.
- Study of effects on nonlinearities on transverse instability continues.
- Study of the effect of the 20th pole of a narrow quad was completed.

- A PCR for the increase in G&A rate was submitted.
- UAL/TEAPOT tracking module has been integrated with the UAL Accelerator Propagator Framework (APF) and fully documented:
<http://www.ual.bnl.gov/ref/v1/doc/doxygen/html/namespaceTEAPOT.html>
- Fast TEAPOT, the first application of the Accelerator Propagator Framework (APF), has been released (bld006 snapshot). Fast TEAPOT is a configurable efficient tracking engine based on the combination of sector linear matrices and TEAPOT symplectic integrators. (<http://www.ual.bnl.gov/ref/v1/doc/examples/FastTeapot/>)
- An open directory of examples illustrating different features of the UAL environment has been added into the CVS and downloadable package. At this time, it includes five examples: (<http://www.ual.bnl.gov/v1/docs.htm#examples>). These examples have been selected to become a part of the User manual.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
12603.4	12603.4	12401.5	0.00	0.0%	201.9	1.6%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period CV of -\$118.5K (-77%) is labor driven WBS 1.5.12.1.

Project Impact: None.

Corrective Action: None.

WBS 1.9.5.1 -Ring Controls Integration

Yury Eidelman attended the November EPICS collaboration meeting. At this meeting he presented a talk on a workstation application he developed to simplify managing alarm screen configurations.

WBS 1.9.5.2 - Power Supply Controls

The study into the causes of infrequently occurring PSC transmission errors continues. The latest evidence indicates a mechanical cause, rather than a design flaw in the PSC. The rate of errors can be increased by “handling” the fibers and connectors for certain channels on certain PSC modules. The investigation will now focus on the fiber optic transceivers, their connection to the PCB board, and the fiber connections.

The final shipment of ring PSC and PSI modules was tested at BNL. This shipment was meant to include all the manufacturing, and test procedure enhancements accumulated since production

began. Unfortunately, some steps were omitted, requiring minor local rework. Although no further orders are expected, a series of telephone conference have been held with the vendor to rectify the situation for any future purchases.

LANL was contacted and is being kept apprised of the situation so that items already shipped can be checked and either reworked at LANL or returned to the vendor for rework.

BNL is in the process of shipping 60 PSIs to the ORNL power supply group for power supply testing.

WBS 1.9.5.3 – Diagnostics

Work continues on the BLM IOC application. Current efforts are focusing on removing the performance bottleneck. Streamlining driver and device support functions have raised the limit from 30Hz to 55Hz, which still falls short of the 60Hz requirement. More improvements in device support are planned, and the tests are being repeated using a faster processor.

The Beam Current Monitor Labview code was enhanced to support automatic calibration of the transformer using a calibration pulse. This calibration is deemed important for accurate current difference measurement. Performance limitations also appeared in BCM software. A redesign increased throughput to the 6Hz requirement. Further improvements are possible via planned hardware (PCI digitizer) upgrades. A faster processor is likely in this system as well.

WBS 1.9.5.4 - Vacuum

Johnny Tang from ORNL visited BNL for a week to consult with local experts on strategies to migrate from PLC-5 to the ControlLogix model of PLC. We took advantage of this visit to participate in the discussions (a similar conversion process is planned for the ring RF PLC), and to plan a reciprocal visit later this month.

A second ControlLogix PLC was configured so that work can begin on the Ring valve control logic, and interfaces between the HEBT PLC system and the ring PLC system.

WBS 1.9.5.6 – RF

The infrastructure for communication between the DSP and EPICS has been demonstrated using shared memory, and sending signals (interrupts) in both directions (DSP to EPICS and EPICS to DSP). A mapping of shared memory regions to process variables has been developed.

Work is underway to interface the LLRF configuration application through the control system to the LLRF system for cavity tests later this month. In addition, results of intermediate DSP calculations will be made available via process variables and displayed on EDM screens or StripTool displays.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
4575.3	4352.6	4371.3	(222.67)	-4.9%	(18.7)	-0.4%

Variance Statement: Cum variances are within thresholds. No analysis required.
Current period SV of -\$93.9K (-44.1%) is driven by 1.9.5.3 Diagnostics, SV -\$75.8K; whereas Diagnostic & Collimator Controls material delivery and fabrication are delayed.

Project Impact: None.

Corrective Action: None.

IV. Earned Value Reports and Charts

Dollars

The graph displays the number of nodes in the network over 100 iterations for six different algorithms. The Y-axis represents the number of nodes (60,000 to 110,000), and the X-axis represents the iteration number (0 to 100). The algorithms are: Black (highest), Red, Blue, Green, Cyan, and Magenta (lowest). All algorithms show a rapid increase in nodes within the first 10 iterations, followed by a plateau.

Iteration	Black	Red	Blue	Green	Cyan	Magenta
0	78,000	78,000	77,500	63,500	64,500	65,500
10	104,000	81,500	78,500	65,000	66,000	67,000
20	104,000	85,000	81,500	67,000	67,500	68,000
30	104,000	85,000	-	-	-	-
40	104,000	85,000	-	-	-	-
50	104,000	85,000	-	-	-	-
60	104,000	85,000	-	-	-	-
70	104,000	85,000	-	-	-	-
80	104,000	85,000	-	-	-	-
90	104,000	85,000	-	-	-	-
100	104,000	85,000	-	-	-	-

Months

**U.S. DEPARTMENT OF ENERGY
COST PERFORMANCE REPORT - WORK BREAKDOWN STRUCTURE (FORMAT 1)**

PROJECT TITLE: SPALLATION NEUTRON SOURCE				REPORTING PERIOD: 1-Nov-02 thru 30-Nov-02						PROJECT NUMBER: 99-E-334			
PARTICIPANT NAME AND ADDRESS: Brookhaven National Laboratory Brookhaven, NY				BCWS PLAN DATE: October 1999						START DATE: October 1998			
										COMPLETION DATE: November 2006			
WORK BREAKDOWN STRUCTURE	CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
	Budgeted Cost		Actual Cost of Work Performed	Variance		Budgeted Cost		Actual Cost of Work Performed	Variance		Budgeted	Revised Estimate	Variance
	Work Scheduled	Work Performed		Schedule	Cost	Work Scheduled	Work Performed		Schedule	Cost			
1.1.3 Rings System Development	0.0	0.0	0.00	0.0	0.0	5,115.0	5,115.0	5,112.9	0.0	2.1	5,115	5,115	0.0
1.5 Ring & Transfer Line System	786.9	959.4	1,710.5	172.5	(751.1)	62,568.4	61,909.9	61,606.1	(658.5)	303.7	112,217	112,217	0.0
1.5.1 HEBT (High Energy Beam Transport) Systems	43.1	35.7	180.7	(7.4)	(145.0)	5,759.0	6,277.1	4,986.7	518.2	1,290.5	9,841	9,841	0.0
1.5.2 Injection Systems	43.8	39.2	171.8	(4.7)	(132.6)	4,815.9	5,164.8	5,089.4	348.9	75.4	9,350	9,350	0.0
1.5.3 Magnet Systems	118.5	120.89	283.2	2.4	(162.3)	11,244.9	11,100.4	11,570.7	(144.5)	(470.3)	16,935	16,935	0.0
1.5.4 Power Supply System	10.4	11.7	49.0	1.4	(37.3)	1,238.1	978.4	1,163.8	(259.7)	(185.4)	3,746	3,746	0.0
1.5.5 Vacuum System	59.8	60.0	144.9	0.2	(84.9)	5,225.1	5,130.1	5,314.7	(95.0)	(184.6)	9,758	9,758	0.0
1.5.6 RF System	126.6	208.4	226.4	81.8	(17.9)	7,544.0	7,278.4	7,355.2	(265.5)	(76.7)	11,936	11,936	0.0
1.5.7 Ring Systems Diagnostic Instrumentation	111.8	127.0	164.2	15.2	(37.2)	7,348.4	7,014.1	7,018.3	(334.2)	(4.2)	13,584	13,584	0.0
1.5.8 Collimation and Shielding	21.6	15.9	63.6	(5.6)	(47.7)	1,839.5	1,651.4	1,713.3	(188.0)	(61.8)	3,380	3,380	0.0
1.5.9 Extraction System	43.5	105.4	90.1	61.9	15.2	1,786.2	1,776.5	1,844.7	(9.7)	(68.2)	6,165	6,165	0.0
1.5.10 RTBT (Ring to Target Beam Transport) System	54.0	81.3	64.1	27.3	17.1	3,163.2	2,934.4	3,147.2	(228.9)	(212.8)	7,235	7,235	0.0
1.5.11 Cable	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.0	0.0	1	0.7	0.0
1.5.12 Technical Support	153.9	153.9	272.4	0.0	(118.5)	12,603.4	12,603.4	12,401.5	0.0	201.9	20,287	20,287	0.0
WBS SUBTOTAL	786.9	959.4	1,710.5	172.5	(751.1)	67,683.4	67,024.9	66,719.1	(658.5)	305.8	117,332		
UNDISTRIBUTED BUDGET													
SUBTOTAL	786.9		1,710.5			67,683.4		66,719.1			117,332		
MANAGEMENT RESERVE													
TOTAL	786.9		1,710.5			67,683.4		66,719.1			117,332		
RECONCILIATION TO CONTRACT BUDGET BASE													
DOLLARS EXPRESSED IN:			SIGNATURE OF PARTICIPANT'S PROJECT DIRECTOR:								DATE:		
THOUSANDS			Jie Wei								December 17, 2002		